

Phonocardiographic Findings in Persistent Truncus Arteriosus^{*}

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Persistent truncus arteriosus is characterized by a single arterial trunk arising from the heart and supplying the systemic, pulmonary, and coronary circulations. There are remnants neither of an atretic pulmonary artery nor aorta (Lev and Saphir, 1942; Collett and Edwards, 1949). Despite excellent clinical reviews (Anderson, Obata, and Lillehei, 1957; Tandon, Hauck, and Nadas, 1963; McCue *et al.*, 1964), differences of opinion still exist in regard to the auscultatory findings. The purpose of this report is to analyse the phonocardiographic observations in 13 infants with persistent truncus arteriosus.

CLASSIFICATION

Collett and Edwards (1949), in their classical review, divided persistent truncus arteriosus into four major types. For the present study we will follow the clinical classification proposed by Tandon *et al.* (1963), combining types II and III and excluding type IV of Collett and Edwards (1949). In essence, this includes all cases of truncus arteriosus in which the pulmonary arteries arise close together from the left inferior aspect of the common arterial trunk or independently, either from the dorsal or lateral walls of the truncus.

SUBJECTS AND METHODS

All infants were evaluated at the University of Florida in their first year of life (B. E. Victorica *et al.*, unpublished data). The diagnosis was established by necropsy in 7 patients, by angiocardiography in 4, and by operation in the remaining 2. Eleven infants were of type I and 2 of type II (Tandon *et al.*, 1963).

All phonocardiograms were obtained as part of the routine clinical evaluation and no special filters or techniques were used. Phonocardiograms in all 13 cases

were taken on an Electronics for Medicine Research Recorder Model PR-7, using EM or Sanborn microphones and a standard frequency between 40 and 2000 c.p.s. They were recorded (along with respiration and lead II of the electrocardiogram) at 75 mm./sec. from at least four areas (apex, fourth left intercostal space, second left intercostal space, and second right intercostal space). In 3 patients, phonocardiograms were also obtained with a Cambridge MC-IV recorder, using a Cambridge microphone with the low frequency limit set at 20 c.p.s.

PHONOCARDIOGRAPHIC FINDINGS

All phonocardiograms except one showed a prominent, constant ejection click most distinct over the fourth left space. Each had a high frequency early-peaking crescendo-decrescendo or only decrescendo systolic murmur over the apex and fourth left space. The murmur always ended before the second sound (Fig. 1). A low frequency diastolic flow murmur, usually preceded by a summation ($S_3 + S_4$) or fourth sound was present in 11 patients.

Five phonocardiograms showed a "wide" (0.04 to 0.05 sec.) second sound. These did not allow differentiation into two separate components, but were composed of multiple closely approximated components, noted best over the base of the heart (second left and/or second right space) (Fig. 2). In only 3 infants was the second sound "pure" (0.02 sec. or less), forming basically a single component. Four phonocardiograms showed two discrete components of the second sound. In 3 of the 4, the two components were better seen over the second right space rather than over the left (Fig. 3). In the remaining case the second sound was partially obscured by a continuous murmur (Fig. 4).

DISCUSSION

Among the 13 phonocardiograms all except one showed a characteristic pattern over the apex and

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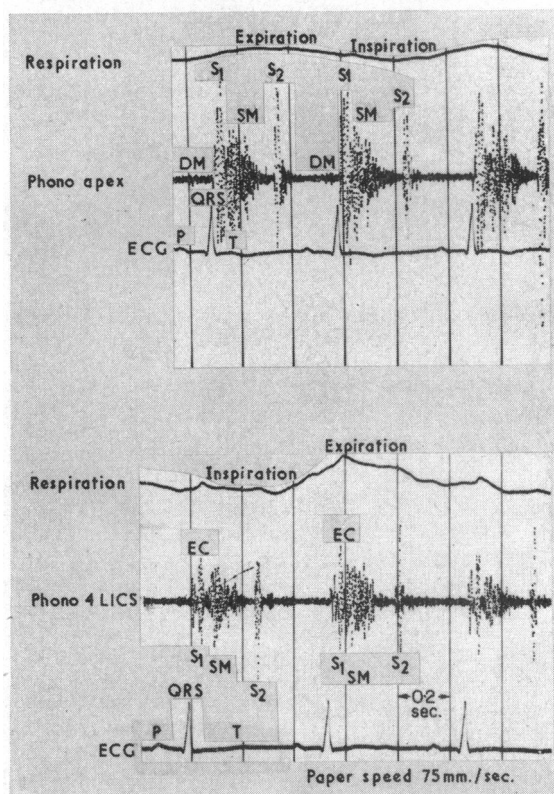


FIG. 1.—Typical phonocardiogram recorded over the fourth left intercostal space (4LICS) and apex. Common findings are: a prominent constant ejection click, a high frequency decrescendo systolic murmur occupying most of systole but ending just before S_2 , and a low frequency diastolic flow murmur. S_1 = first heart sound, EC = ejection click, SM = systolic murmur, S_2 = second heart sound, and DM = diastolic murmur.

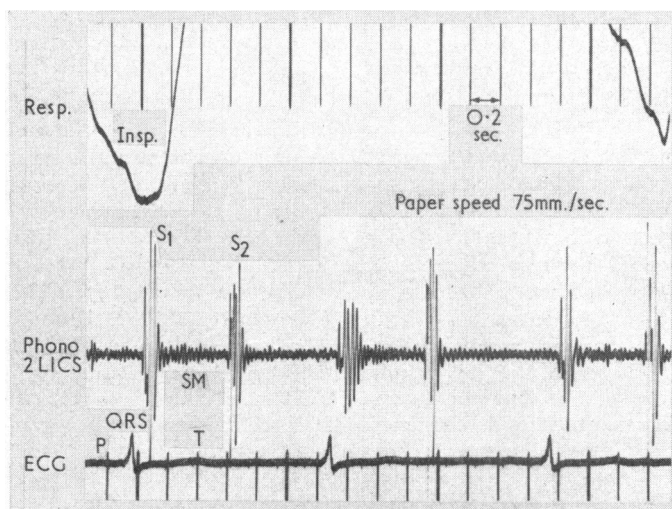


FIG. 2.—Phonocardiogram showing a "prolonged" or "wide" second sound (0.04 sec.) composed of multiple closely approximated components over the second left intercostal space (2LICS).

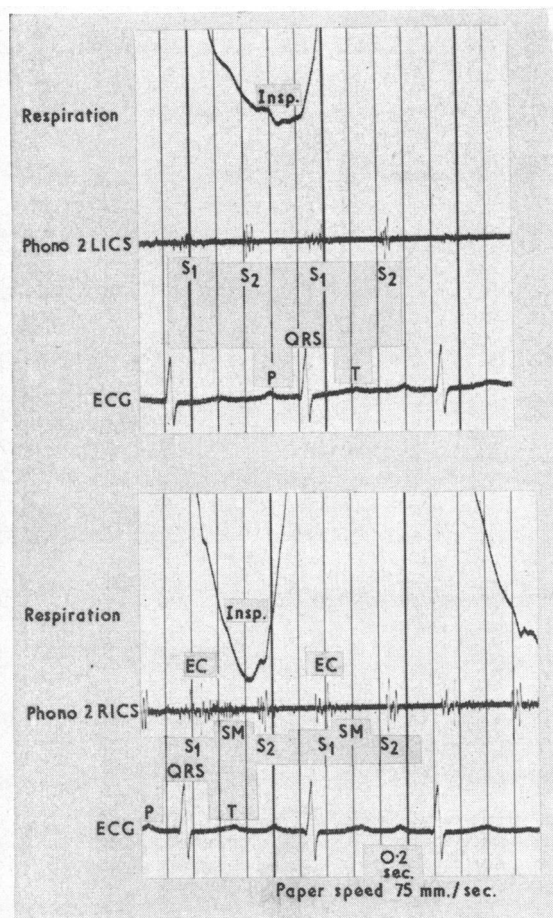


FIG. 3.—Phonocardiogram showing two distinct components of the second sound over the second right intercostal space (2RICS). The splitting is definite and increased during inspiration. Note "wide" second sound over the second left intercostal space (2LICS).

fourth left space. The presence of a prominent and constant systolic ejection click has been stressed (Tandon *et al.*, 1963; Keith, Rowe, and Vlad, 1967). As in aortic valvar stenosis, truncal systolic ejection sounds are not influenced by respiration. The typical high frequency early crescendo-decrescendo systolic murmur always ended before the second sound. This is in contrast to many isolated ventricular septal defects in which the holosystolic murmur ends with or even obscures the second sound. Persistent truncus arteriosus is characterized by a large ventricular septal defect, with both ventricles emptying simultaneously into a common arterial trunk which usually has an abnormal truncal valve. The combination of a constant ejection sound and an ejection type systolic murmur suggests

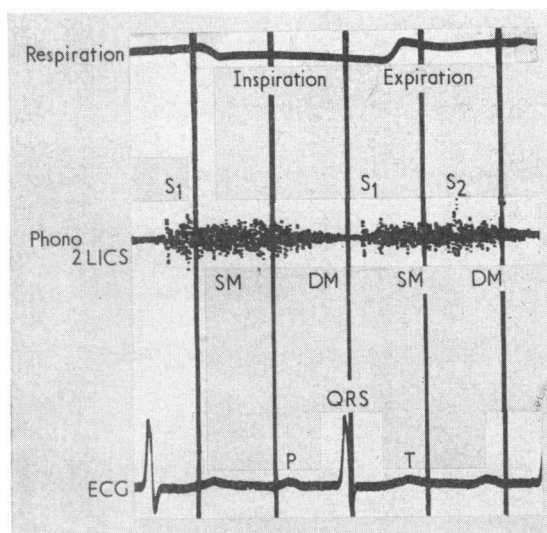


FIG. 4.—Phonocardiogram of the only patient in our series with a continuous machinery-type murmur simulating patent ductus arteriosus over the second left intercostal space (2LICS).

that, at least in part, the murmur is due to relative truncal stenosis (McKusick, 1958). Furthermore, Tandon *et al.* (1963) found 8 patients with ejection murmurs resembling "aortic" stenosis. Murmurs of truncal stenosis were not identified by auscultation in our series, though catheterization data suggested this in 2 patients.

Apical flow murmurs, usually preceded by a summation ($S_3 + S_4$) or fourth sound, were common. These low frequency, medium to low intensity diastolic murmurs of relative mitral stenosis are frequently present in patients with increased pulmonary blood flow.

In contrast to the findings of McCue and her associates (1964), a continuous murmur was present in only one of our patients. The rarity of such machinery murmurs mimicking a patent ductus arteriosus has been emphasized by others (Anderson *et al.*, 1957; Tandon *et al.*, 1963; B. E. Victorica *et al.*, unpublished data; Campbell and Deuchar, 1961).

Diastolic murmurs of truncal valve insufficiency (Tandon *et al.*, 1963; Deely, Hagstrom, and Engle, 1963) were not recorded in this series, though they were heard in one case.

Detailed analysis of the second sound over the base of the heart was of particular interest. The most common pattern over the second left space was a "prolonged" (Keith *et al.*, 1967) or "wide" (Gasul, Arcilla, and Lev, 1966) second sound composed of multiple closely approximated components. The duration (0.04 to 0.05 sec.) of this second

sound might explain the "splitting" described on auscultation in some of these patients (Levine and Harvey, 1959). In contrast to some reports (Anderson *et al.*, 1957; McCue *et al.*, 1964; Taussig, 1947; Rowe and Vlad, 1953; Armer, DeOliveira, and Lurie, 1961), a "pure" narrow second sound, composed of a single component, was uncommon in our series. Auscultatory evidence of a split second sound has been reported (Tandon *et al.*, 1963; Singleton, McNamara, and Cooley, 1955), but positive documentation is rare (Goldberg and McGregor, 1958). In patients with large left-to-right shunts two components about the second sound, simulating splitting, could be produced by a single component S_2 followed by a prominent opening snap of relative mitral stenosis. Four patients showed two discrete components of the second sound. The fact that the second component was best recorded over the base, with the maximal delay in inspiration, rules out this possibility (Margolies and Wolferth, 1932; Leatham and Towers, 1951; Leatham, 1952). We think the two components are due to asynchronous tensing of the walls of the "aorta" and pulmonary arteries. This was documented in one infant by cine-angiogram which showed that both filling and pulsation of the pulmonary artery were slightly later than those in the truncus. Tandon *et al.* (1963), on the other hand, suggested the presence of more than three cusps as explanation for this phenomenon.

One interesting observation was that in 3 of those 4 patients who had two components of the second sound, they were seen only in the second right space tracing, whereas the S_2 was "wide" over the second left space. This finding has been previously described as characteristic of congenitally corrected transposition of the great vessels (Gasul, Graettinger, and Bucheleres, 1959). No explanation for this phenomenon was apparent.

SUMMARY

The phonocardiographic findings in 13 infants with persistent truncus arteriosus (types I and II) are presented. Each case still had increased pulmonary flow, but the phonocardiograms revealed several features that could be used to differentiate persistent truncus arteriosus from other forms of left-to-right shunts below the atrioventricular valve.

The most common pattern was a first sound followed by a prominent ejection click which did not vary with respiration. An early crescendo-decrescendo high frequency systolic murmur ending just before S_2 and maximal along the lower left sternal border and apex was the rule. Although a single "pure" second sound has been said to be the hall-

mark of persistent truncus arteriosus, this finding is uncommon. The rule was a widened second sound (0.04 sec. or greater) composed of multiple closely approximated components or two distinct components of the second sound, usually best seen in the second right space recording.

The usual diastolic murmur is a mid-precordial and apical one occupying mid and late diastole. Diastolic murmurs of truncal valve insufficiency were not recorded in this series; and in only one case was a continuous murmur resembling a patent ductus arteriosus noted.

The phonocardiographic findings thus are similar to any large ventricular septal defect with much increased pulmonary flow. The main differences are that in persistent truncus arteriosus an ejection click is constant, and that the systolic murmur ends distinctly before S_2 giving it qualities of semilunar valve functional stenosis. In contrast to previous concepts, the second sound and its component parts in persistent truncus arteriosus cannot be used as a reliable indicator to differentiate it from other large left-to-right shunts.

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